

Columbia/Snake River Mainstem TMDL

Presentation to WA Department of Ecology

February 26, 2002

Lacey, WA



Agenda

Part 1 - Overview of our entire mutual effort on the Columbia and Snake River main stem TMDLs

Part 2 - Overview of the Temperature TMDL process to date.

Part 3 - Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

Part 1

**Overview of our entire mutual effort on the
Columbia and Snake River main stem
TMDLs**

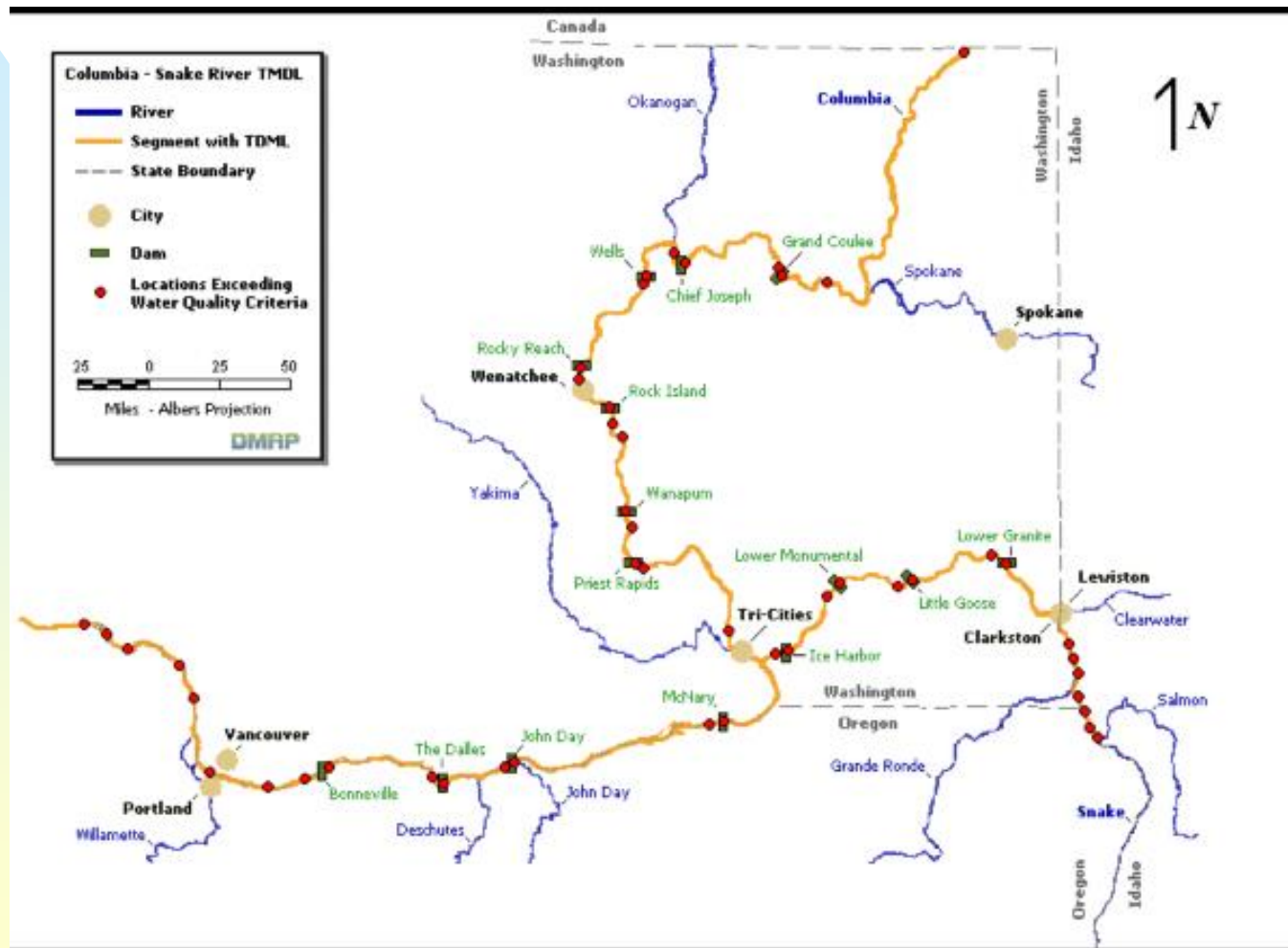
Memorandum of Agreement

- **ID DEQ, OR DEQ, WA Ecology and EPA**
- **Purpose: To establish Total Dissolved Gas and Temperature TMDLs for the Main Stem Columbia and Snake Rivers**
- **In Cooperation with the Columbia Basin Tribes**

Geographic Scope

- **Columbia River from the Canadian border (RM 745.0) to the Pacific Ocean.**
- **Snake River from it's confluence with the Salmon River (RM 188) to it's confluence with the Columbia River (Columbia RM 324.3).**

Geographic Scope



TMDLs under this effort

- *Columbia/Snake River Mainstem Temperature TMDL*
- Lower Columbia River Total Dissolved Gas TMDL
- Lake Roosevelt/Mid Columbia/Snake River Total Dissolved Gas TMDL

Columbia/Snake River 303(d) Listings for Temperature

- **Columbia River RM 0 to RM 309.3 from the Pacific Ocean along the Washington/Oregon border is currently listed as water quality impaired for temperature on both the Washington and Oregon 303(d) Lists.**
- **Snake River from it's confluence with the Salmon River to it's confluence with the Columbia River is listed as water-quality impaired for temperature on the Washington, EPA and/or Oregon 303(d) Lists.**

Columbia/Snake River 303(d) Listings for Temperature (cont)

- **In Washington, 29 segments of the Snake and Columbia Rivers are on the 303(d) list.**
- **September 4, 2001 letter from Ecology to EPA: Temperature TMDL should address the entire main stems of the Columbia and Snake Rivers in WA.**

Columbia/Snake River 303(d) Listings for Dissolved Gas

- **Columbia River RM 0 to RM 309.3 from the Pacific Ocean along the Washington/Oregon border is currently listed as water quality impaired for dissolved gas on both the Washington and Oregon 303(d) Lists.**
- **Snake River in Oregon and Washington is listed as water-quality impaired for dissolved gas on both the Washington and/or Oregon 303(d) Lists.**

Columbia/Snake River 303(d) Listings for Dissolved Gas (cont.)

- **The Columbia River from the confluence with the Snake to the Canadian Border is listed as water-quality impaired for dissolved gas by the State of Washington.**

Roles of Key Players

- Oregon and Washington developing dissolved gas TMDL for Lower Columbia - Draft 2/2002
- Washington developing dissolved gas TMDL for Mid-Columbia and Lower Snake TMDL - 12/2002
- ***EPA is taking technical lead on temperature TMDL - expected to be completed 12/2002***
- EPA developing dissolved gas TMDL for portions within tribal waters
- EPA in lead to work with tribes

Other Related Activities

- **Endangered Species Act**
- **2000 Federal Columbia River Power System Biological Opinion**
 - **Water Quality Reasonable and Prudent Alternatives**
 - **Appendix B called for development of a Water Quality Plan**

State and Tribal Agencies with a CWA role in the Project Area

○ States

- ▣ **Idaho Department of Environmental Quality**
- ▣ **Oregon Department of Environmental Quality**
- ▣ **Washington Department of Ecology**

○ Tribes

- ▣ **Colville Confederated Tribes (EPA promulgated standards)**
- ▣ **Spokane Tribe of Indians (tribal approved standards)**
- ▣ **Other Columbia Tribes - federal trust responsibility**

Consultation and Coordination with Columbia Basin Tribes

- **July 2001 Letter to Tribal Chairs committing to tribal consultation and coordination process and providing an update on process**
- **Grant to National Fish and Wildlife Foundation to develop and implement tribal consultation and coordination**
 - **September Meeting/CRITFC**
 - **Mid/Upper Columbia meeting - 2002**
 - **Other meetings**
- **Letter to Tribal Chairs informally notifying them of the opportunity to consult**

Lake Roosevelt TDG TMDL

- **"Tribal waters" require EPA to develop this effort**
- **Washington Ecology committed to coordinate with the Tribes**
- **Spokane and Colville are key - Held discussions with them in November, 2001 and January 2002.**
- **Met with Bureau of Reclamation at Grand Coulee - November 5/6, 2002.**
- **Coordinate with Transboundary Gas Group**

Coordination Efforts

- **EPA/State/Tribal Team meeting on a monthly basis to address technical, policy and outreach issues.**
- **Technical sub-committee meets as needed (frequently of late)**
- **Tribal staff participation is key to TMDL development.**
- **Western Governors' Association has helped facilitate interstate coordination.**

Outreach Efforts

- **Many informational meetings have been held with industry groups, congressional delegations and other interested parties.**
- **Further informational meetings are planned to share information as TMDLs are developed**
- **July, 2001 Workshops - Spokane, WA & Portland, OR**
- **October, 2001 Workshops - Lewiston, ID & Pasco, WA**
- **March, 2002 Public Hearings Lower Columbia TDG TMDL**
- **March, 2002 Workshops - Vancouver, WA & Toppenish, WA**

For more information

- **Region 10 Home Page**
www.epa.gov/r10earth/index.htm
- **Columbia/Snake Rivers TMDL Web Page**
www.epa.gov/r10earth/columbiainstemtmdl.htm
- **Office of Water TMDL Home Page**
www.epa.gov/OWOW/tmdl/index.html



Part 2

Overview of the Temperature TMDL process to date.

TMDL Development

- Model Development ⚙️
- Problem Assessment ⚙️
- TMDL 📁

Why Do We Need A Model?

- We need to estimate temperatures under unimpounded conditions for which measurement data is scarce
- We have conflicting measurements
- We do not have measurements at all river locations of interest
- We need to estimate influence of different sources

Model

- RBM 10
- One Dimensional Energy Budget Mathematical Model.
- Results:
 - Cross sectional averaged temperature
 - Daily or hourly average temperature

Model Development

- **Developed for the Columbia/Snake TMDL**
- **Peer Reviewed**
- **Intensive Regional Review - industry, contractors, federal agencies.**
- **Numerous public meetings, two public workshops**
- **Number of meetings with Corps: Division, Districts, WES**

RBM 10 Error Estimates

<i>Location</i>	<i>Mean Difference (Obs-Sim)</i>	<i>Standard Deviation</i>
<i>Snake River @Ice Harbor</i>	0.05 deg C	1.2
<i>Columbia River @Bonneville</i>	0.04 deg C	1.3

Error Estimates From Other Studies

RISLEY (1997) - Tualatin River

Max Mean Difference = 3 Deg C

Mostly < 1 Deg C

BATTELLE-MASS1 (2001) - Columbia River

RMS Error = 0.59 - 1.52 Deg C

HDR/PORTLAND STATE/IPC (1999) - Snake River

AME = 0.6-2.3 Deg C (1992 data)

AME = 0.5-2.0 Deg C (1995 data)

CHEN (1996) - Grande Ronde River

Error = -2.20 - 8.28 Deg C (Summer Max)

Error = -1.21 - 7.69 Deg C (Avg 7-day Max)

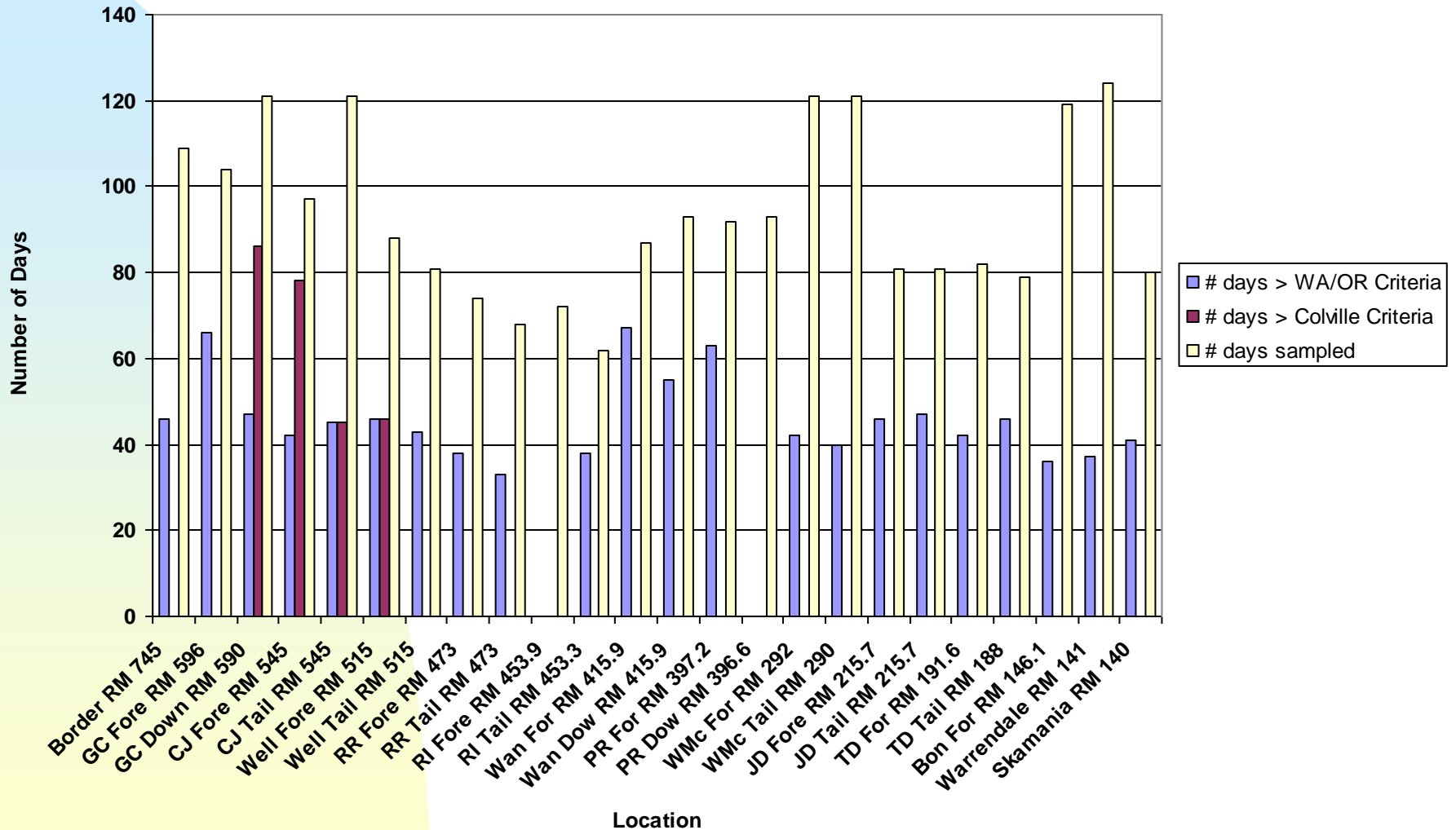
Problem Assessment

Does water temperature in the
Columbia and Snake Rivers
exceed Water Quality Standards?

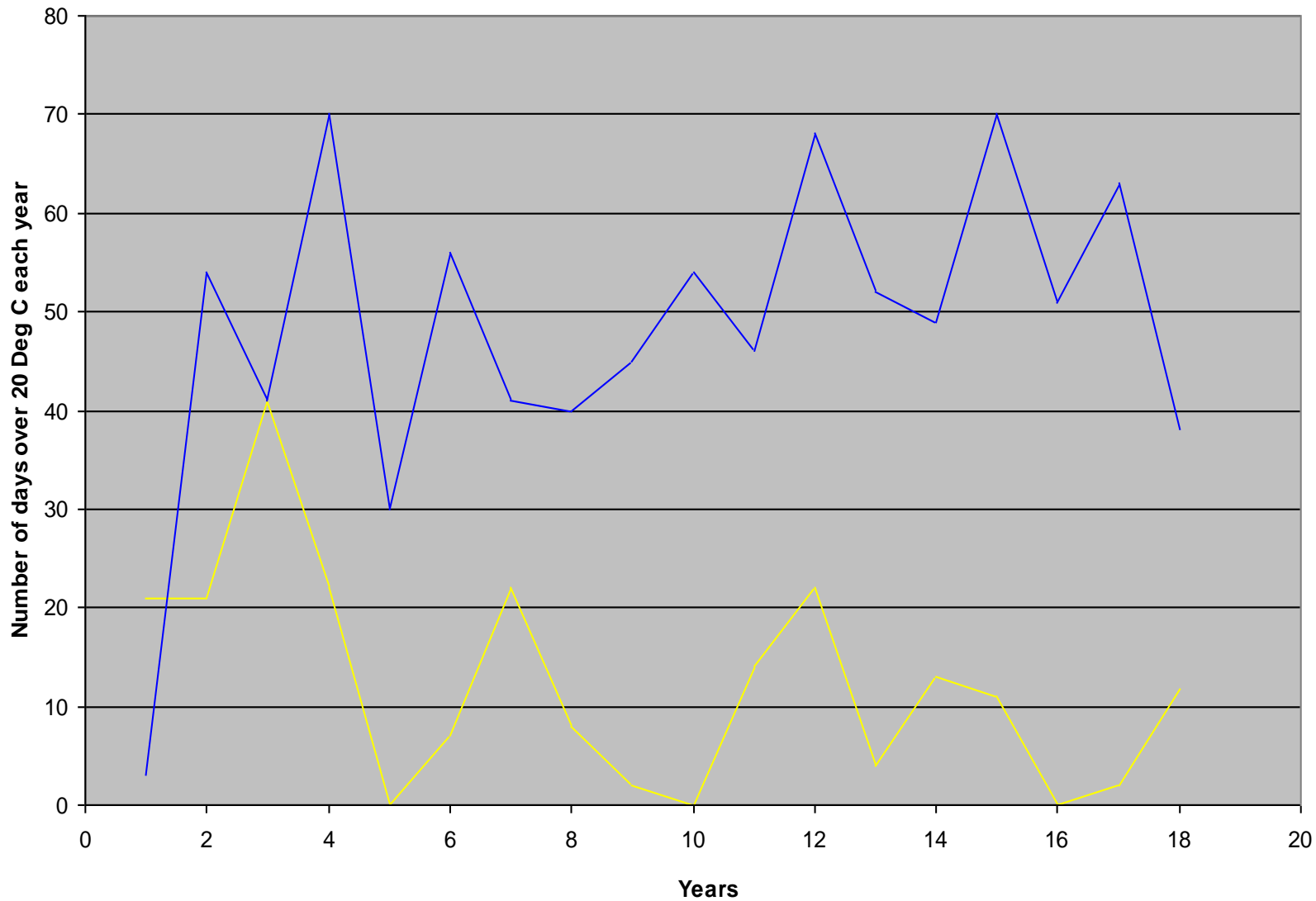
Problem Assessment

- 1) Does temperature exceed the Water Quality Criteria?
- 2) Does temperature exceed the Water Quality Criteria due to human activities?

July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



Number of Days that Exceed 20 Deg C at Bonneville Dam: Comparison of the two periods 1939-1956 and 1976-1993



Problem Assessment

- Principle cause for the warming trend in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.

Part 3

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

- 1) Determine Target Temperatures
- 2) Establish Loading Capacity
- 3) Allocate Available Load

Water Quality Standards

The WQS for this TMDL are the natural temperatures of the Columbia and Snake main stems plus small incremental increases due to human activity.

Water Quality Standards

Columbia Main Stem from Coast to OR/WA Border:

“Temperature shall not exceed 20 C (68 F) due to human activities. When natural conditions exceed 20 C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 C (0.5 F) nor shall such temperature increases at any time exceed 0.3 (0.5 F) due to a single source or 1.1 C (2.0 F) due to all such activities combined.”

Water Quality Standards

Natural stream temperatures for this TMDL are those that would occur in the main stems within the TMDL study area in the absence of human activity within the study area.

They are termed site potential temperatures in this TMDL.

Water Quality Standards

- OR - allow an increase of 0.14 C when the SP > criteria,
- allow increase up to criteria when SP < criteria.

WA & Colvilles

- allow an increase of 0.3 C when the SP > criteria,
- allow reach dependent increases when SP < criteria. Eg $t = 23 / (T + 5)$ is the increase allowed in L. Roosevelt.

Snake River Target Temperatures

<u>River Reach</u>	<u>Criterion</u>	<u>SP<Criterion</u>	<u>SP>Criterion</u>
Salmon River to OR/WA Border			
	12.8/17.8	Up to Criterion	0.14 C
OR/WA Border to Clearwater River			
	20 C	1.1 C	0.3 C
Clearwater River to Mouth			
	20 C	$t=34/(T+9)$	0.3 C

Columbia River Target Temperatures

<u>River Reach</u>	<u>Criterion</u>	<u>SP<Criterion</u>	<u>SP>Criterion</u>
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Canadian Border to Grand Coulee

16 C	$t=23/(T+5)$	0.3 C
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Grand Coulee to Chief Joseph

16 C	$t=23/(T+5)$	0.3 C
------	--------------	-------

Chief Joseph to Priest Rapids

18 C	$t=28/(T+7)$	0.3 C
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Priest Rapids to OR/WA Border

20 C	$t=34/(C+9)$	0.3 C
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OR/WA Border to the Mouth

20 C	1.1 C	
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0.14 C
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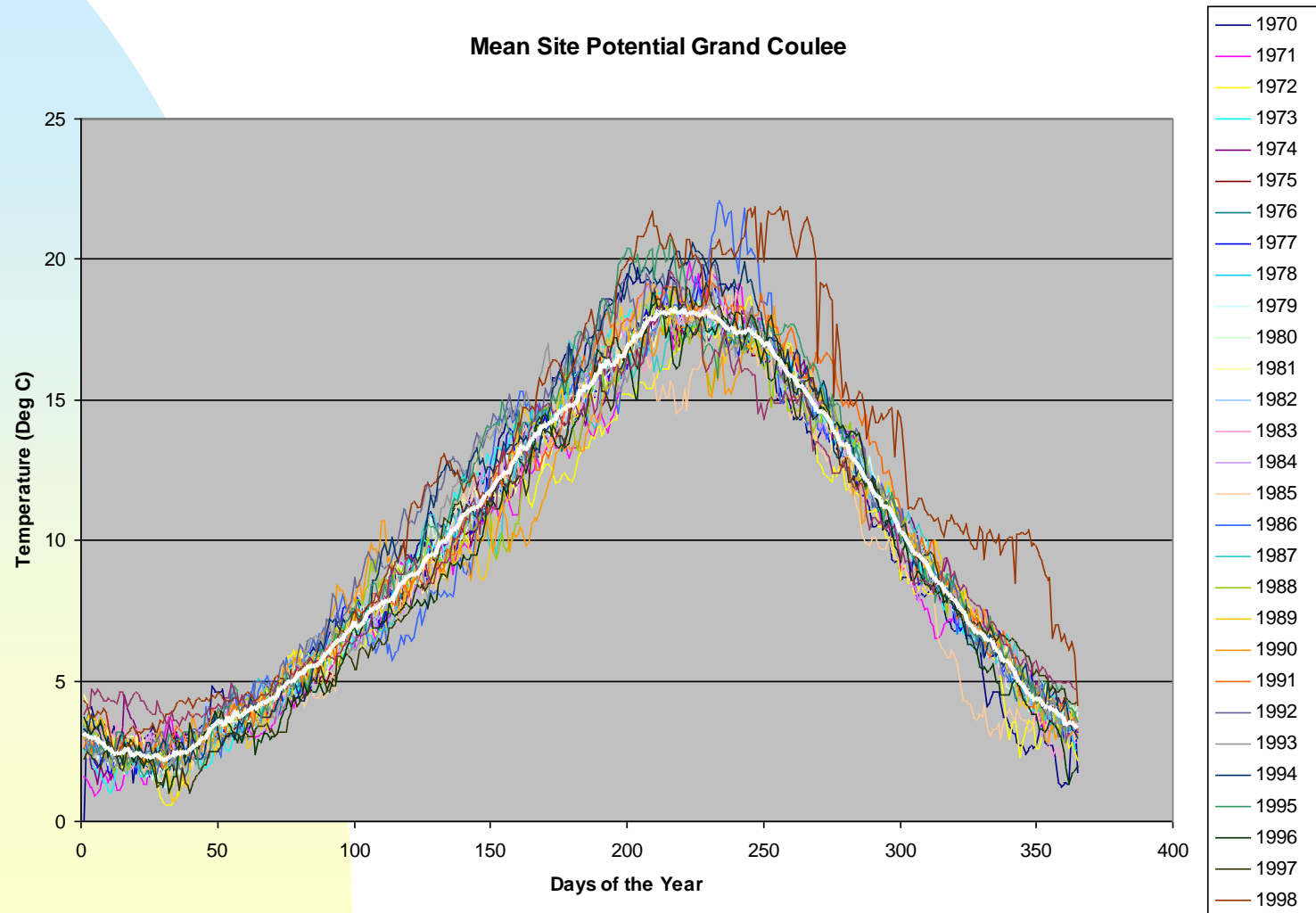
Determine Target Temperatures

1. Determine the Site Potential (SP) Temperatures
2. Apply the WQS for each reach.

Site Potential Temperatures

The site potential temperatures vary temporally and geographically. They vary from day to day and from year to year. They also vary with state or tribal jurisdiction and within jurisdictions they vary along the longitudinal axis of the rivers.

To account for this variability we utilize the mean daily site potential temperatures based on 30 years of simulations using actual weather and flow data.

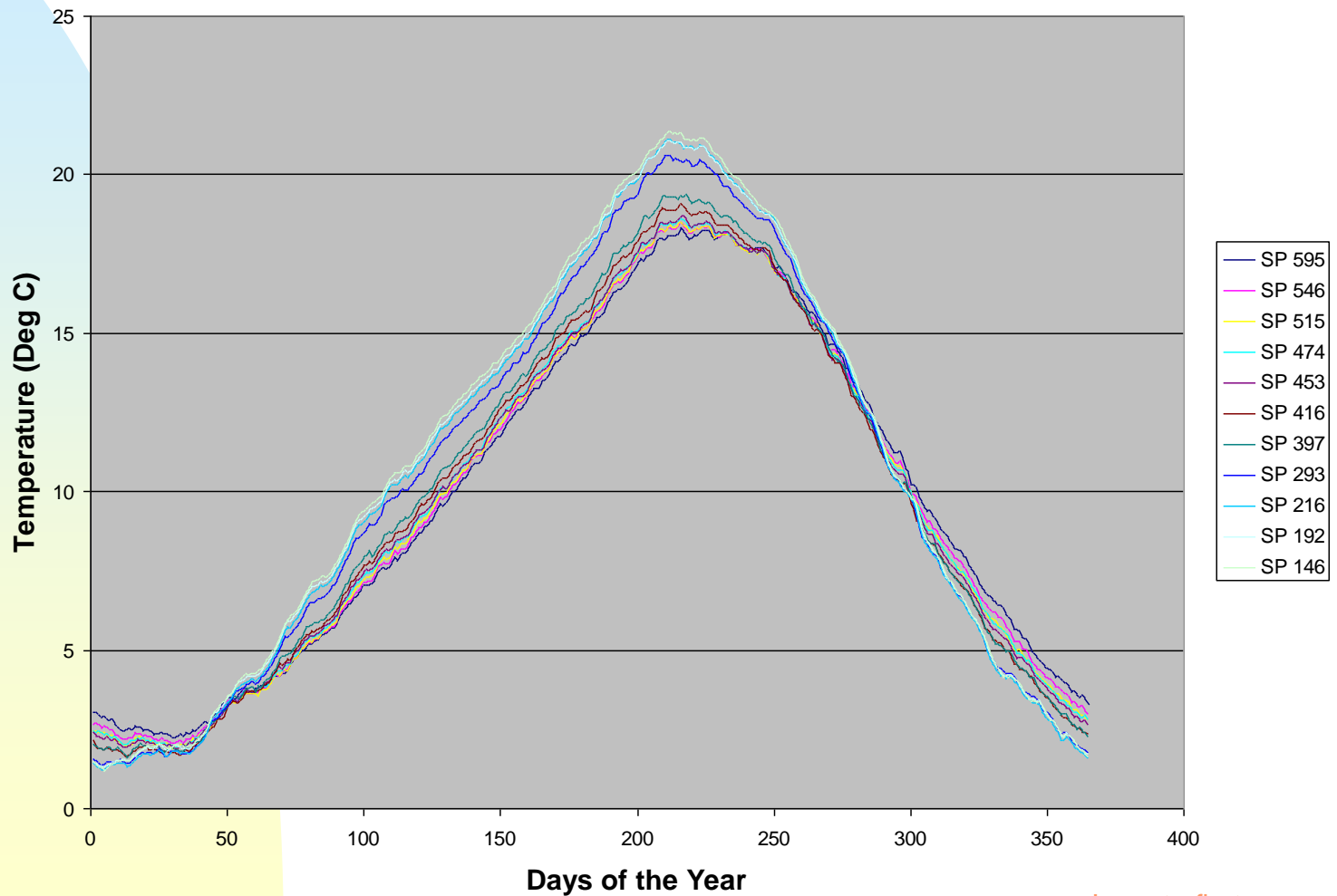


Site Potential Temperatures

- We have simulated Site Potential Temperatures for River Reaches.
- The reaches are defined by the dams. There are 15 reaches. The target site for each reach is in the tailrace of the dam at the foot of the reach.
- We have estimated the mean site potential (30 year mean) for each day of the year at each target site.

Site Potential Temperatures

Site Potential Temperature at each Target Site



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Target Temperatures

- Apply Target Temperatures to the Average SP Reach by Reach.
- Average Target Temperatures based on 30 years of weather and flow data.
- Average Target Temperature for every day of the year for each reach of the rivers.

Target Temperatures

But.....

There's a catch!

Target Temperatures

If we apply the WQS reach by reach to determine the target temperatures reach by reach we will exceed the target temperatures in the downstream reach.

Columbia River Target Temperatures

<u>River Reach</u>	<u>Criterion</u>	<u>SP<Criterion</u>	<u>SP>Criterion</u>
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Canadian Border to Grand Coulee

16 C	$t=23/(T+5)$	0.3 C
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Grand Coulee to Chief Joseph

16 C	$t=23/(T+5)$	0.3 C
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Chief Joseph to Priest Rapids

18 C	$t=28/(T+7)$	0.3 C
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Priest Rapids to OR/WA Border

20 C	$t=34/(C+9)$	0.3 C
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OR/WA Border to the Mouth

20 C	1.1 C	0.14 C
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Target Temperature

- Decided that we need to meet the more stringent WQS: in this case the standards in the lower reach along the border.
- So we need to determine the target temperature in the upstream reaches that will allow achievement of the target temperature in the lower reach.
- Ie: We have to allocate temperature among the upstream sources.

Target Temperatures

There are many ways to allocate the target temperature:

1. Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.
2. Base the incremental increase for a reach on impacts to temperature in the reach. Eg larger reservoirs get bigger increments.
3. Give the sources above the OR/WA border a “bubble allocation”. The target temperature at the beginning of the reach has to be .14 above SP. Let the sources allocate that among themselves.

Target Temperatures

We have completed the first example approach: **Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.**

When Site Potential is less than the Criterion:
incremental increase in each reach is 0.15 C

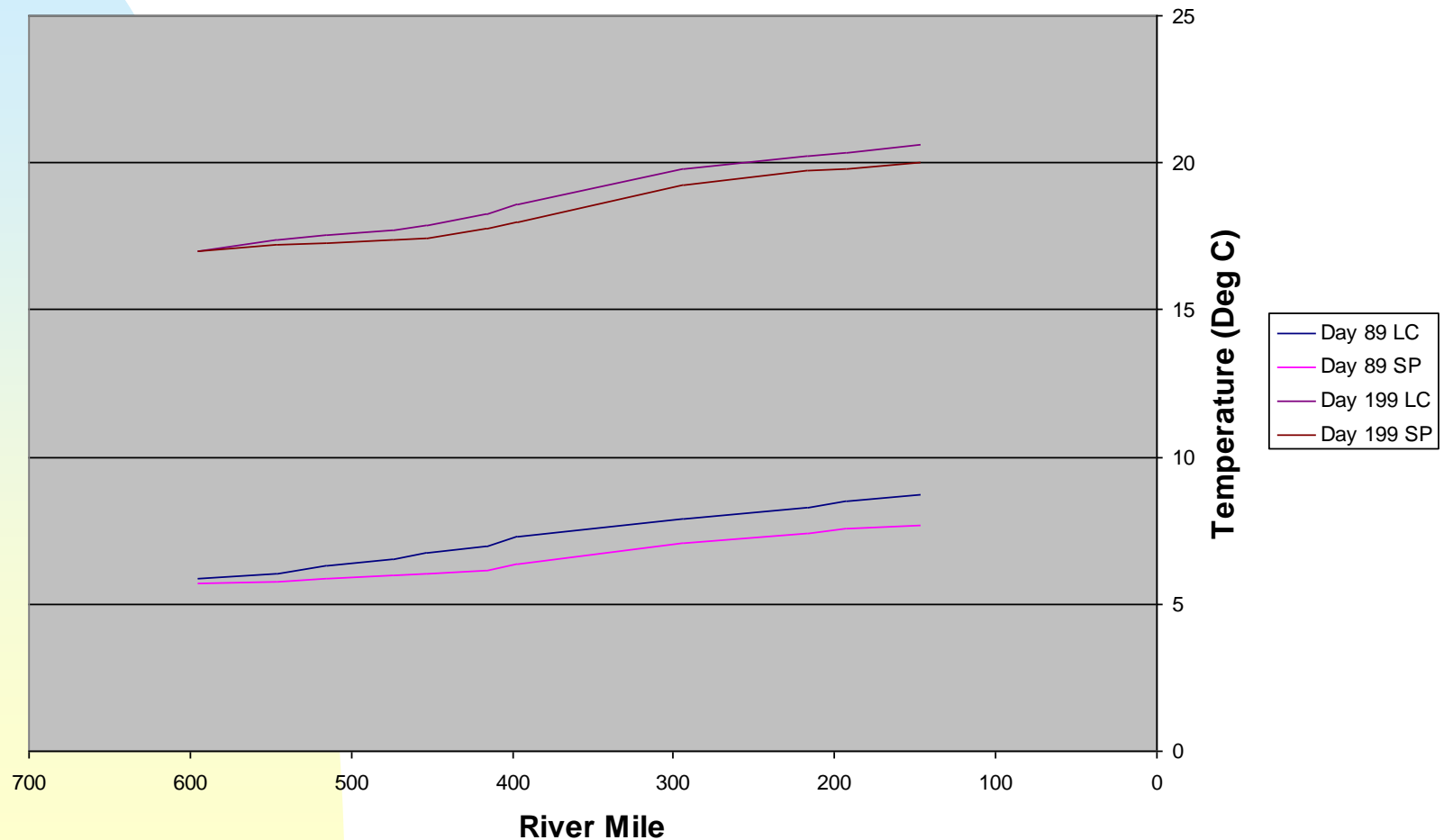
When Site Potential Exceeds Criterion:
incremental increase in each reach is 0.02 C

Target Temperatures

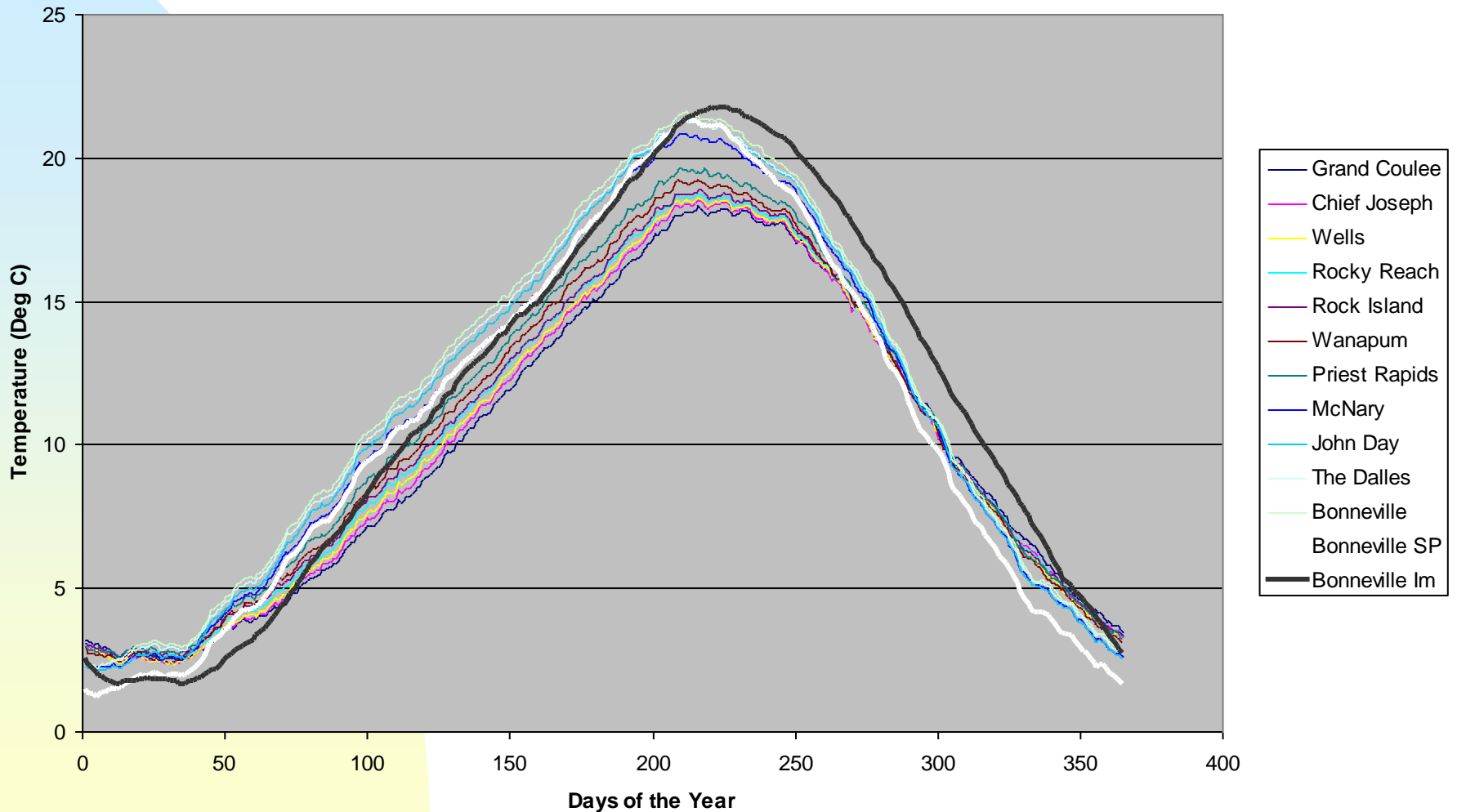
- Target Temperature @ Grand Coulee Target Site =
 - $SP + 0.15\text{ C}$ when $SP < \text{Criteria}$
 - $SP + 0.02\text{ C}$ when $SP > \text{Criteria}$
- Target Temperature at each subsequent target site =
 - Upstream Temperature + 0.15 C when $SP < \text{Criteria}$
 - Upstream Temperature + 0.02 C when $SP > \text{Criteria}$

Target Temperatures

Target Temperature and Site Potential Along the Columbia

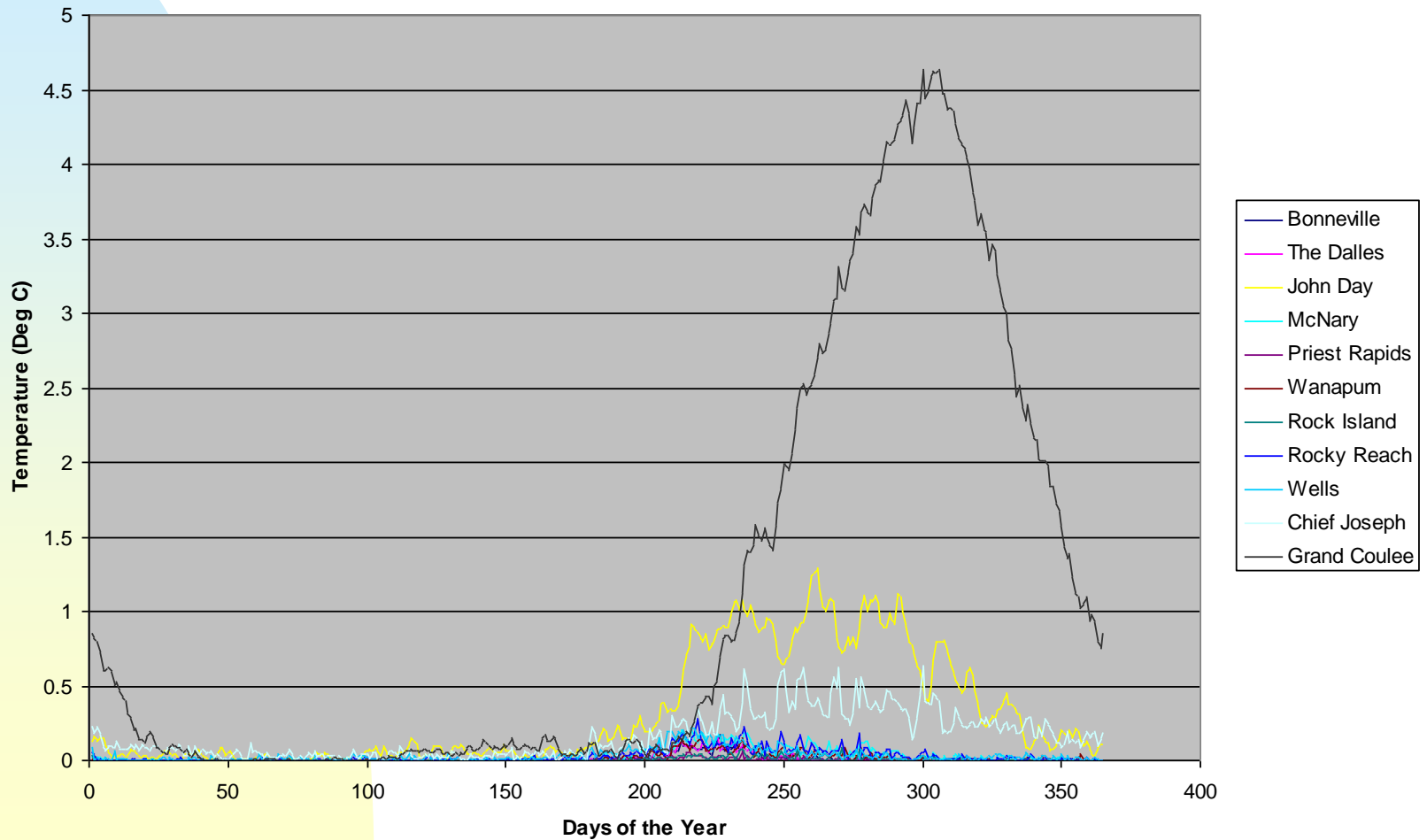


Columbia TMDL at each Target Site with the Bonneville Site Potential and Impounded



Needed Temperature Improvement

Temperature Improvement Needed at each Target Site - Columbia

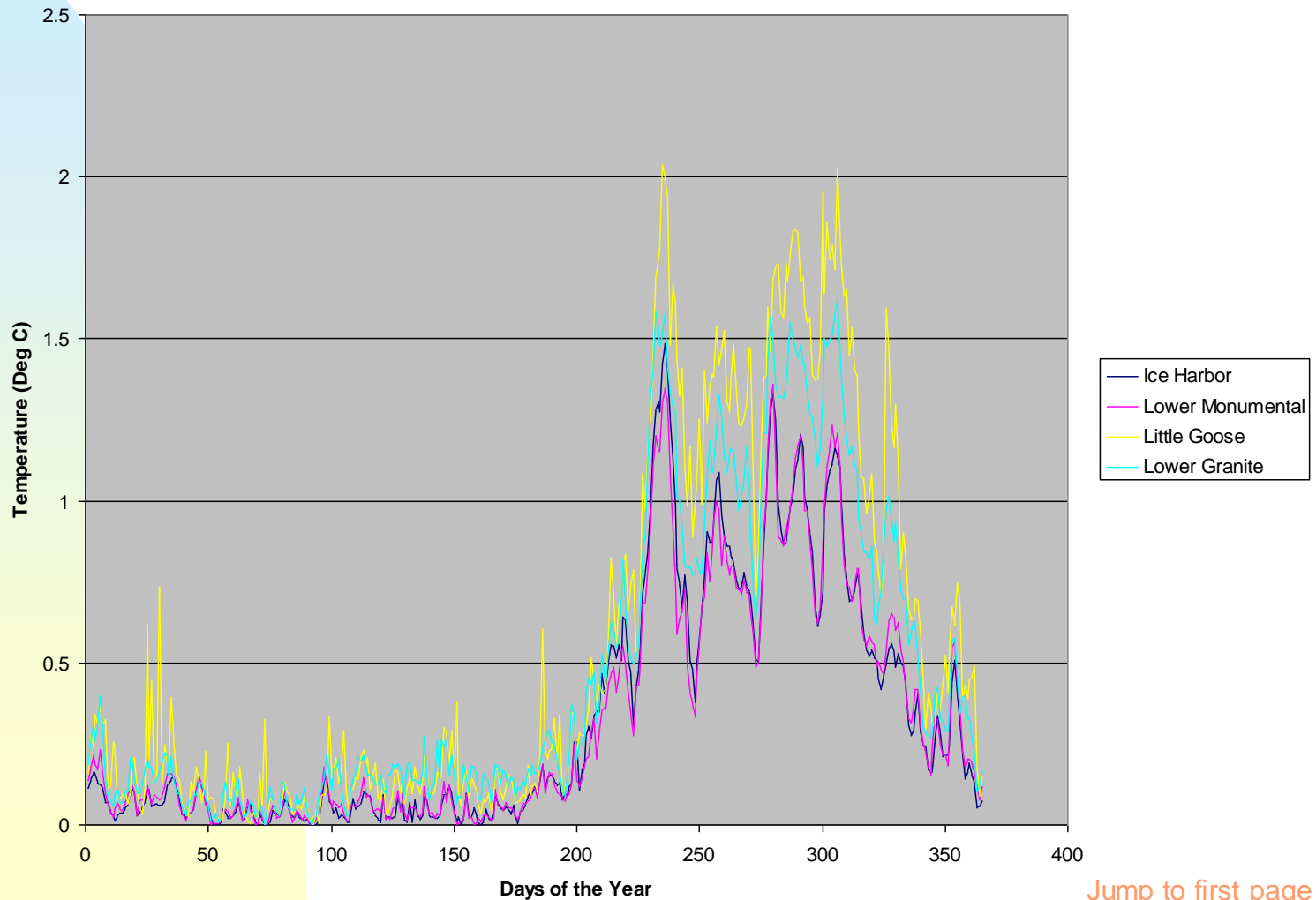


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Needed Temperature Improvement

Temperature Improvements Needed at each Target Site - Snake



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Part 3

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

- 1) Determine Target Temperatures❄
- 2) Establish Loading Capacity
- 3) Allocate Available Load

Establish Loading Capacity

- Loading Capacity in this TMDL is in terms of Temperature rather than thermal load.
- Temperature is being used as “another appropriate measure” as per the regulations.
- Thermal load is not used because the dams are the most significant causes of temperature change but they do not discharge a thermal load to the river and they can alter load without affecting temperature.

Establish Loading Capacity

For this TMDL the Loading Capacity is the Target Temperature.

Allocate Available Load

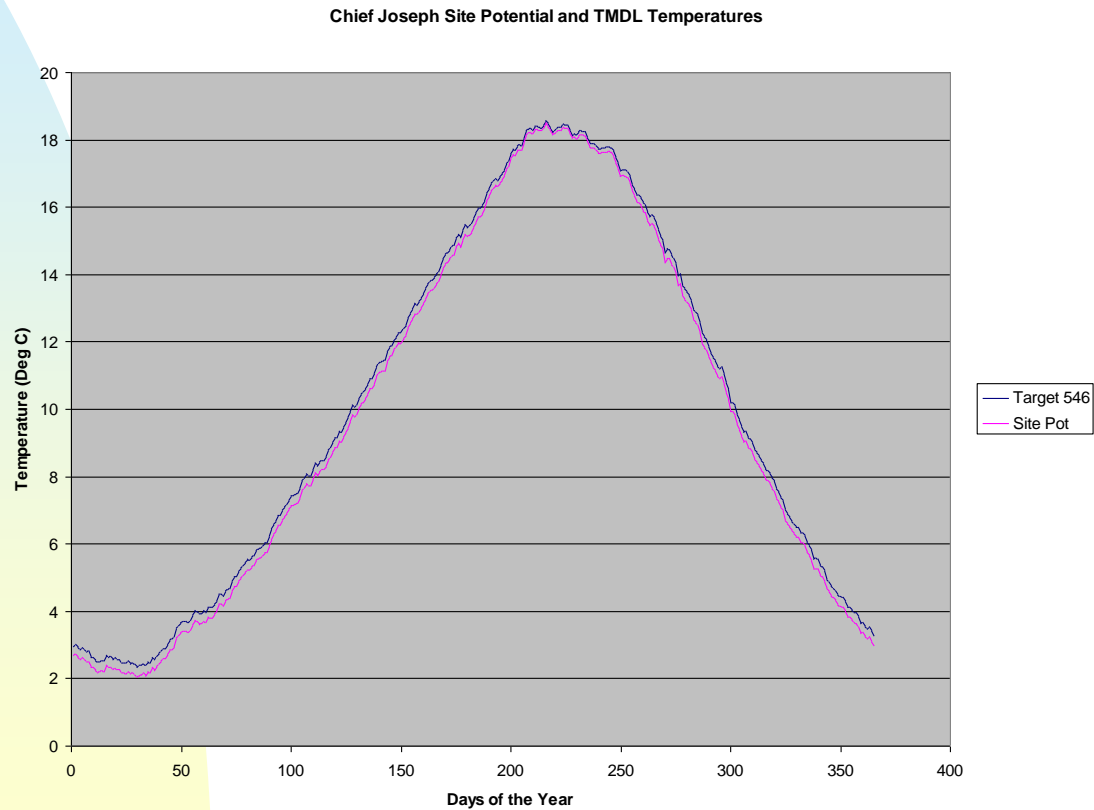
The load available for allocation to dams, point sources, non-point sources, and future growth is the incremental increase allowed at each target site to achieve the target temperature:

- 0.02 C when the SP > criteria
- 0.15 C when the SP < criteria

Allocation Table - Chief Joseph

Day	Upstream LC (°C)	LC (°C)	Increment (°C)	Dams Allocation (°C)	Other Sources (°C)	Future Growth (°C)
89	5.9	6.05	.15	.14	.005	.005
199	17.29	17.31	.02	.01	.005	.005

Chief Joseph TMDL



Allocate Available Load

- What do these small allocations mean?
- Do they pass the laugh test?
- They mean that essentially no measurable increase in temperature due to human activity is allowed at each target site.
- There is sufficient loading capacity for existing point sources and some future growth.

Point Sources

- 78 Point Sources
- Most cause less than 0.014 C increase.

Bubble allocation for these

- 3 - 4 Point Sources cause > 0.014 C increase.
- These will get individual allocations.

Tributaries

One Tributary, the Umatilla River, has a TMDL for Temp. It will get its TMDL allocations in this TMDL.

167 Tribs do not have TMDLs. They will get their existing loads. Small Tributaries with no data may get bubble loads.

Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Spokane R.	7.0	1.9
Okanagan	17	4.9
Yakima R.	17	4.8

Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Deschutes	16	4.6
Willamette	3.2	0.92

Snake Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Salmon	1.5	0.43
Grande Ronde	6.0	1.7
Clearwater	1.5	0.48

Tributaries

- Essentially this TMDL is based on site potential in the main-stems.
- Water flowing into the TMDL from tributaries and boundary conditions is not at site potential.
- Improvement in temperature in the tributaries or at the boundary conditions could lower the site potential of the main-stems.
- We are doing an analysis of tributary temperature effects on main-stem site potential to develop thresholds of ΔT in the tributaries that would warrant re-opening this TMDL.

Measuring Compliance

Long Term System Level Compliance:

- Compliance with the target temperatures. That is, mean water temperature at the target sites equals the target temperatures.

Issues

- Very small allocations - far smaller than detection levels.
- TMDL doesn't account for “unnatural” conditions at boundary and in tributaries.
- Short term, dam specific compliance monitoring may be impossible.
- TMDL addresses daily average temperature.
- “Nothing can be done at dams to improve temperature.”

What the TMDL Does

- Interprets the WQS to provide actual target temperatures for the rivers.
- Quantifies the effects of human activity on river temperature.
- Prioritizes causes of elevated temperature.
- Provides the basis for development of temperature management plans for activities that lead to elevated temperatures.